APPLICATION BENEFITS OF VARIABLE CAPACITY GSHP’S

Bob Brown – VP of Engineering
WaterFurnace International
VS TECHNOLOGY
THE 7 SERIES
THE VARIABLE CAPACITY CONCEPT

- Typically implemented with variable speed drive and a permanent magnet motor for highest efficiency operating between 900 and 4200 rpm.
- The HP operates to match the exact load of the home. Therefore will be operating more of the time. By operating more of the time, the house becomes more consistent in temperature with lower humidity.
- By operating at lighter compressor capacities more of the time the heat exchanger’s are oversized therefore unit has higher efficiency more of the time.
THE VARIABLE SPEED (VS) SYSTEM

- Permanent Magnet Motor Compressor
- VS Inverter Drive
- VS ECM Fan Motor
- VS Pump
- Elect Exp Valve
- Aurora Advanced VS Control
- Communicating T-Stat (no Y1 etc.)
BENEFITS OF VARIABLE CAPACITY GSHP’S
1- EFFICIENCY BENEFITS
EFFICIENCY BENEFITS

- Dual Capacity GSHP part load EER = 27-30
- VS GSHP part load EER = 40+. Approximately 30% improvement.
- Extended operation at lower compressor capacities results in much higher efficiencies.
HEATING EFFICIENCY IMPROVEMENT
(ANNUAL COP)

Indy | Atlanta | Minneapolis | Dallas
--- | --- | --- | ---
2.5 | 4.5 | 3 | 4.5

Water Furnace
Smarter from the Ground Up™
COOLING EFFICIENCY IMPROVEMENT (ANNUAL EER)
HOT WATER ASSIST EFFICIENCY W/ ELECTRIC WH (ANNUAL COP)
2 - MORE EVEN TEMPERATURES IN HOME
COMMUNICATING THERMOSTATS

- Y1, Y2 not possible. Requires a more sophisticated approach such as PID. These include time as a factor and transmit more information.
ROOM TEMPERATURE W/ PID CONTROL

Room Temp vs Setpoint
3 - COMPRESSOR SOFT START
SOFTSTART CAPABILITY

- Variable speed inverter drive lowers inrush current by 80%.
- Reduced light flicker during start up
- Provides a quieter startup
- Reduced shock on compressor and improves reliability
4 - EXTREMELY QUIET OPERATION
QUIET OPERATION

- Operates 80% of the time at a low 15-30% capacity.
- With equally reduced airflow, unit operation is often difficult to detect.
- Usually the most noted feature from customers.
5 - ACTIVE DEHUMIDIFICATION
ACTIVE DEHUMIDIFICATION

o When compressor, fan and pump speed can be varied with advanced controls, and the monitoring of refrigeration pressures and temperatures is possible, dehumidification can be optimized.

o When enabled, this mode allows the variable speed unit to operate in active dehumidification mode producing extremely high latent moisture removal and is controlled by humidity setpoint.

o Results in improved dehumidification for homeowner with a third mode of operation.
6 - BETTER MATCH TO HOME LOAD
WHY LIMIT COOLING SPEED?

- Cooling capacity has been restricted to around 80%. Since we size most earthloops south of 40 deg latitude based upon cooling capacity, any extra cooling capacity results in unnecessary extra earthloop.
- Better balance between heating and cooling loads. (Resembles old Northern Leader).
- Simulations in GeoLink Design Studio show a better balance for most loads.
TYPICAL SINGLE STAGE SYSTEM

- **Supplemental Elect Heat**
- **Total = 3200 hrs**

- Single Spd GSHP in Htg
- Single Spd GSHP in Clg

Heat Gain/Loss vs. Outdoor Air Temperature:
- 2500 hrs at 55°F
- 700 hrs at 75°F
- Total = 3200 hrs
TYPICAL TWO STAGE SYSTEM

Supplemental Electric Heat

Total = 3950 hrs

Combination Partload/Fullload

3100 hrs

850 hrs

Outdoor Air Temperature

Heat Gain/Loss
VS GSHP SYSTEM

Supplemental Elect Heat

Variable Capacity

Total = 5800 hrs

SuperBoost Cooling

Outdoor Air Temperature

Heat Gain/Loss

4400 hrs

1400 hrs

55

75
7 - SUPERBOOST COOLING MODE
SUPERBOOST COOLING

- Earth loops are typically sized based upon maximum heat rejection during cooling. In this case an extra 20-30% is available.
- SuperBoost allows temporary ‘boost’ of cooling capacity for parties etc.
- Occasionally there can be a requirement for a short term ‘boost’ of cooling capacity during a large party but without unneeded increase in loop size.
- The 7 Series allows the user to select ‘SuperBoost’ mode on the thermostat which will allow the 7 Series VS to ramp up an extra 20-30% of cooling capacity IF NEEDED.
- This extra ‘SuperBoost’ will only be available for a 24 hr period and then the unit will revert to normal operation.
- The short term boost does not affect ground loop sizing since it is limited in operation.
8 - ADVANCED CONTROLS: FOR IMPROVED SERVICING AND STATE-OF-THE-ART CONSUMER FEATURES
VARIABLE SPEED REQUIRES MORE SOPHISTICATED CONTROLS

- Traditional Y1, Y2 is inadequate for variable speed Compressor control. A percentage call is needed.
- PWM or communicating control of fan motor and pump is also required.
- Electronic expansion valve might also be needed.
- The Advanced Controls can provide many benefits to both consumer and technician.
- The ‘cost of admission’ to variable speed capability is the development of advanced controls. In our case a whole new platform for both variable speed and traditional dual capacity product.
AURORA RESIDENTIAL FEATURES

- Available on both 5 and 7 Series GSHP’s
- Communicating color thermostats and user interface
- Communicating zoning system
- AID tool troubleshooting
- Symphony Consumer WebLink
- Technician Web Portal
ENERGY MONITORING

- Line Voltage
- Compressor Amps & Watts
- Blower Amps & Watts
- Aux Heat Amps & Watts
- Pump Watts
- Total Watts

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Line Voltage</td>
<td>229 V</td>
</tr>
<tr>
<td>Compressor 1</td>
<td>8.4 A</td>
</tr>
<tr>
<td>Compressor 2</td>
<td>8.5 A</td>
</tr>
<tr>
<td>Blower</td>
<td>1.4 A</td>
</tr>
<tr>
<td>Aux</td>
<td>18.4 A</td>
</tr>
<tr>
<td>Compressor</td>
<td>1843 W</td>
</tr>
<tr>
<td>Blower</td>
<td>165 W</td>
</tr>
<tr>
<td>Aux</td>
<td>4777 W</td>
</tr>
<tr>
<td>FC 1</td>
<td>180 W</td>
</tr>
<tr>
<td>Total</td>
<td>6965 W</td>
</tr>
</tbody>
</table>
REFRIGERANT MONITORING

- Discharge and suction pressures
- Refrigerant temperatures
- Superheat and Cooling

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge</td>
<td>375 psi</td>
</tr>
<tr>
<td>Suction</td>
<td>112 psi</td>
</tr>
<tr>
<td>Temperature</td>
<td>55.0 °F</td>
</tr>
<tr>
<td>Htg LL *</td>
<td>124.5 °F</td>
</tr>
<tr>
<td>Clg LL</td>
<td>165.3 °F</td>
</tr>
<tr>
<td>Sat Evap</td>
<td>36.8 °F</td>
</tr>
<tr>
<td>Sat Cond</td>
<td>72.0 °F</td>
</tr>
<tr>
<td>SuperHeat</td>
<td>12 °F</td>
</tr>
<tr>
<td>SubCooling</td>
<td>10 °F</td>
</tr>
</tbody>
</table>
PERFORMANCE MONITORING

- Entering and Leaving Water Temperature
- Water Flow
- Brine Selection (in AID tool)
- Heat of Extraction/Rejection
- Loop Pressure
- Entering Air at heat pump
- Leaving Air at heat pump

Performance Monitor

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ent Water</td>
<td>42.8 °F</td>
</tr>
<tr>
<td>Lvg Water</td>
<td>37.2 °F</td>
</tr>
<tr>
<td>WaterFlow</td>
<td>8.3 gpm</td>
</tr>
<tr>
<td>Brine</td>
<td>Antifreeze</td>
</tr>
<tr>
<td>Heat of Ext</td>
<td>20,236 Btuh</td>
</tr>
<tr>
<td>Loop Press</td>
<td>37 psi</td>
</tr>
<tr>
<td>Ent Air</td>
<td>71.7 °F</td>
</tr>
<tr>
<td>Lvg Air</td>
<td>95.6 °F</td>
</tr>
</tbody>
</table>
Symphony™

Web Enabled WiFi Comfort System
FIVE IMPORTANT COMPONENTS

- For the Homeowner
  - Web/Wifi thermostat capability
  - Unit energy and whole home energy management
  - Fault notification by Email/Text

- For the Technician
  - Remote monitoring of customers heat pump
  - Fault notification by Email/Text
WHY USE AWL ROUTER AND NOT A WIFI STAT?

• Most implementations of WiFi stats have limited functionality. WiFi Stats only ‘know’ thermostat info because they use 24VAC lines to hp.

• WiFi Stat’s have information issues with many systems such as hydronic and zoning!

• AWL router solution connects internet to Aurora ModBus backbone for full information and communication capability regardless of thermostat!
THE AURORA WEBLINK (AWL)
<table>
<thead>
<tr>
<th>Mode Button</th>
<th>AID Tool</th>
<th>Unit ABC</th>
<th>USB Port</th>
<th>SD Card</th>
<th>WiFi Antenna</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switches between WiFi Internet and Local AID Smart Phone</td>
<td>Local AID Tool connection</td>
<td>Unit ABC Connection</td>
<td>Factory Use</td>
<td>Storage for ‘black box data’</td>
<td>WiFi Antenna to local home Router</td>
</tr>
</tbody>
</table>
**AWL – LOCAL WIRELESS AID TOOL**

- Push AWL Mode button in for 5 sec and enter local mode for wireless AID tool on any smartphone.
SYMPHONY HAS 6 MAIN FEATURES

- AID Tool (Technician Only)
- Historical Data (Technician Only)
- Symphony Dashboard
- Thermostat Management
- WF Energy Monitoring
- Tendril Home Energy Management
TENDRIL HOME ENERGY INTEGRATION

Meet Your Goal

Add these to your savings plan

- Install efficient bulbs in your outdoor light fixtures
  - save up to $24 a year

- Put your outdoor lights on motion detectors or timers
  - save up to $24 a year

Your Savings Goal

15%

1932 lbs of CO2
1494 kWh
$108

Revise your goal
AID TOOL

- Menus very similar to handheld AID tool
- Provides all of the same real time Aurora data
- Change configurations over the web
- Also includes live troubleshooting form.
Historical Data – 10 Sec Data of 100 pts.
VS GSHP = IMPROVED ZONING
VARIABLE CAPACITY IMPROVES ZONING

- VS GSHP were made for zoning!
- Smallest zone can be 20% of heat pump capacity
- Up to 6 zones per heat pump
- No bypass or dump zones
INTELLIZONE2 FEATURES

- Flexibility in Zone Comfort Control
- Flexibility in System Staging (single or dual capacity equipment)
- Eliminating Bypass Damper
- Efficient Space Conditioning
- Full Color Touchscreen IZ2 MasterStat with diagnostics
- Fully Communicating with Aurora controls and 5 Series and 7 Series
QUESTIONS?